



MUSEUM of AFRICAN AMERICAN HISTORY
Boston and Nantucket

African Meetinghouse “ACCESSING HISTORY”

Richard Pizzi, P.E.

Special Thanks to

Rick Wilhelmsen

**HAYWARD
BAKER**

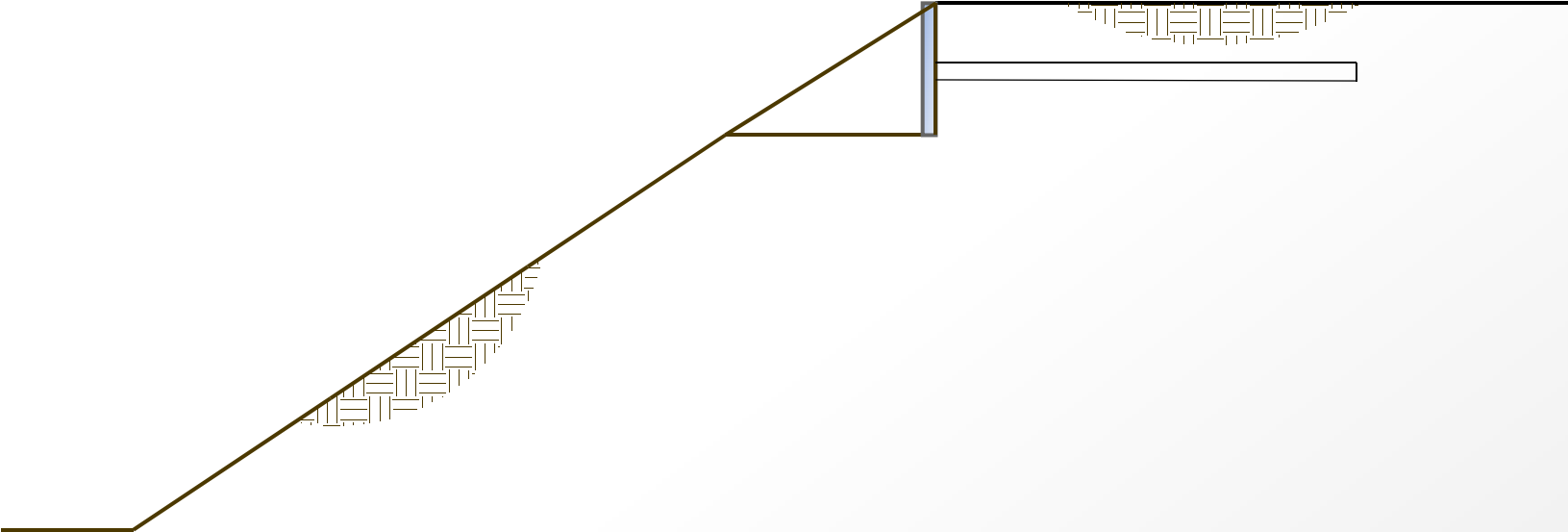
Geotechnical Construction



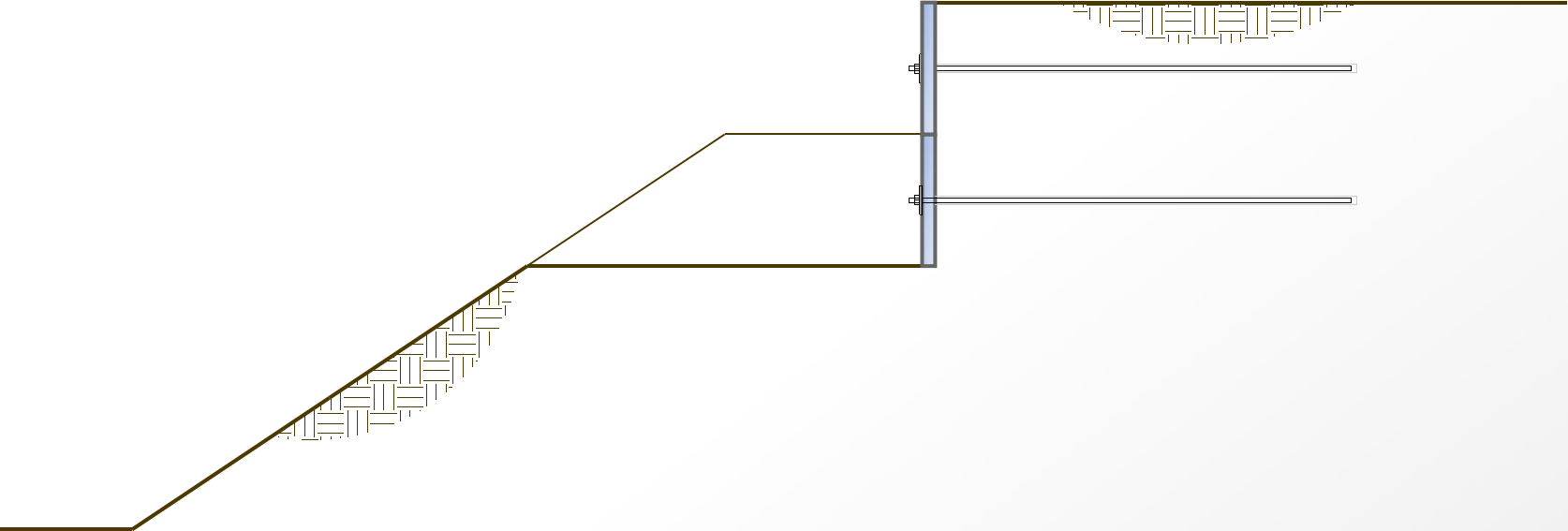
**GEOTECHNICAL
CONSULTANTS, INC**



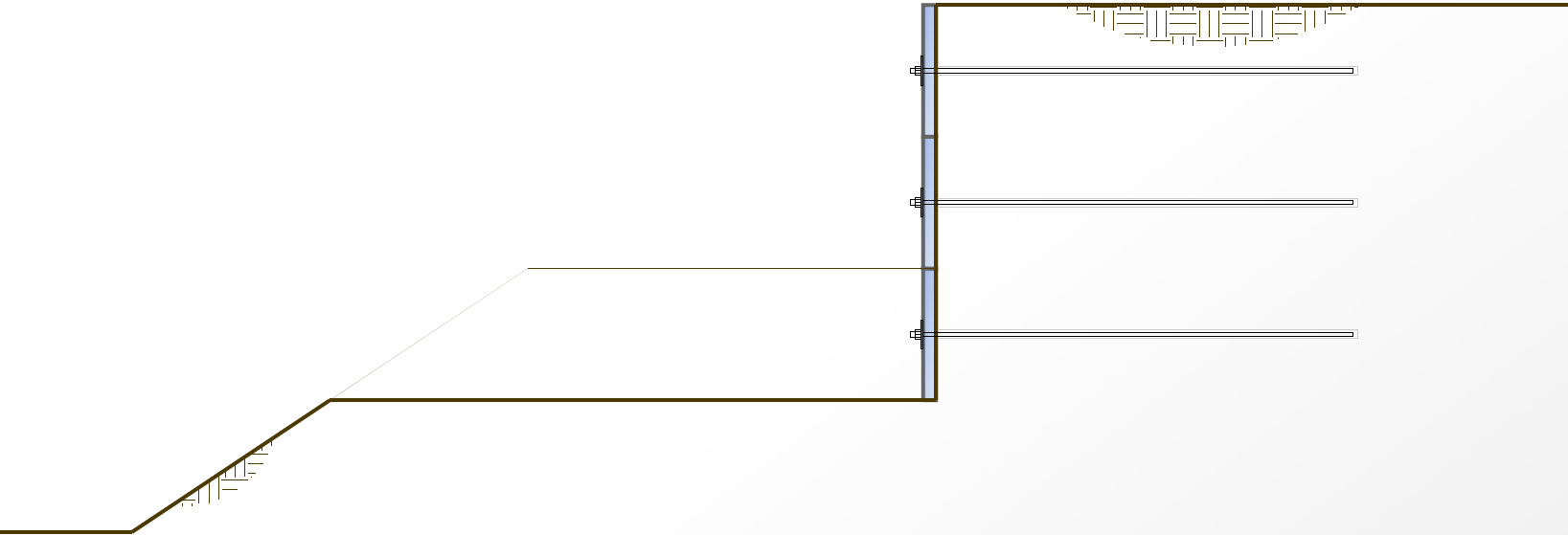
SOIL NAIL WALL CONSTRUCTION



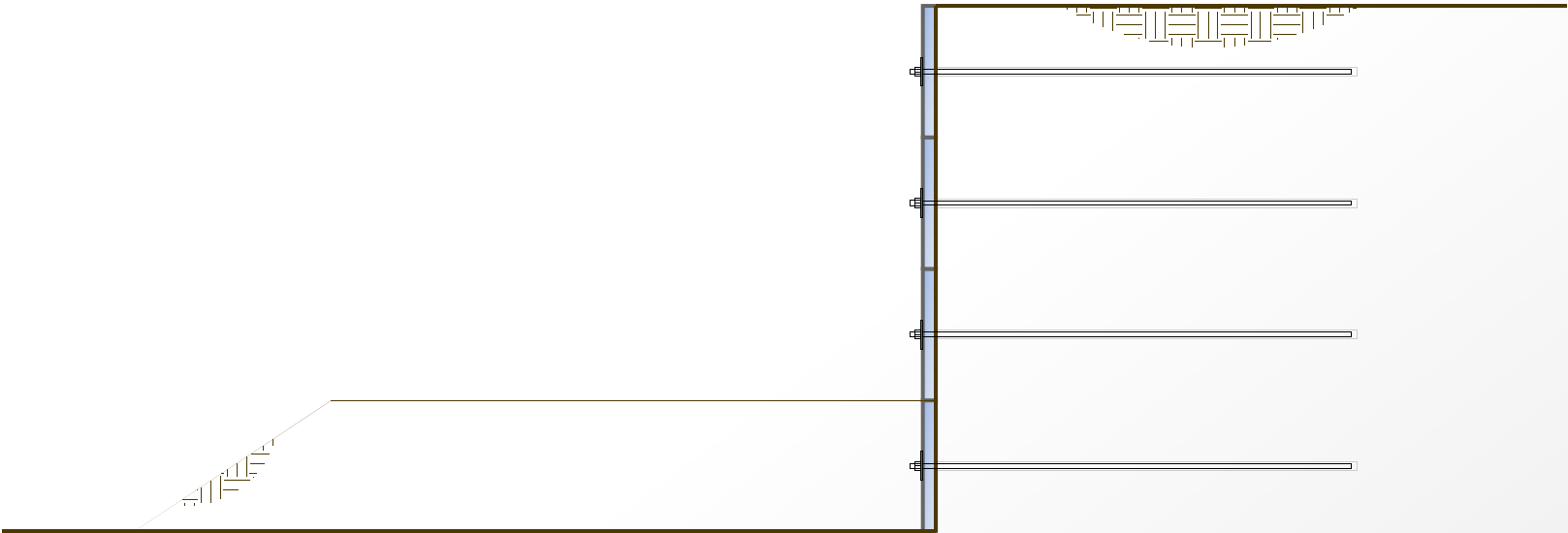
SOIL NAIL WALL CONSTRUCTION



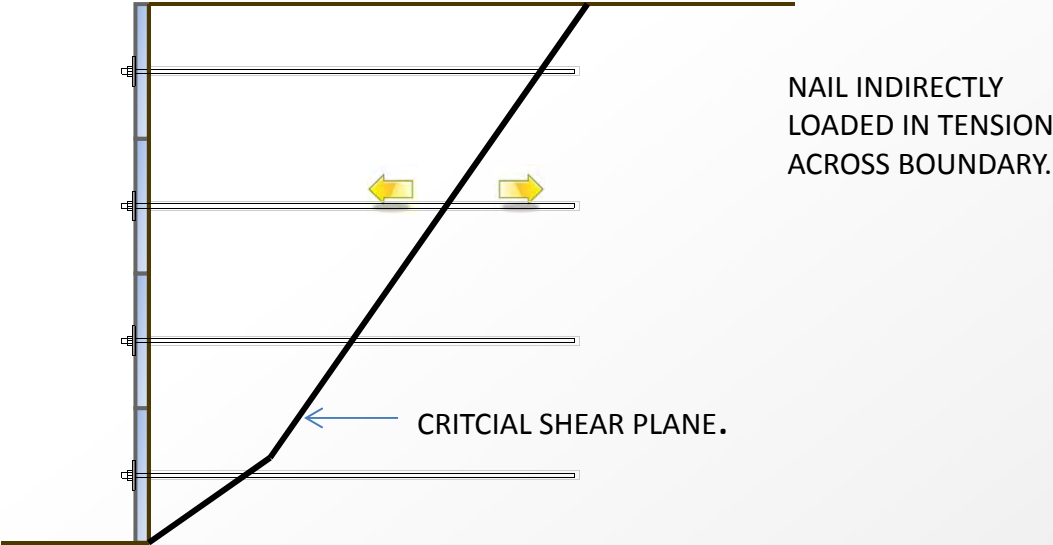
SOIL NAIL WALL CONSTRUCTION



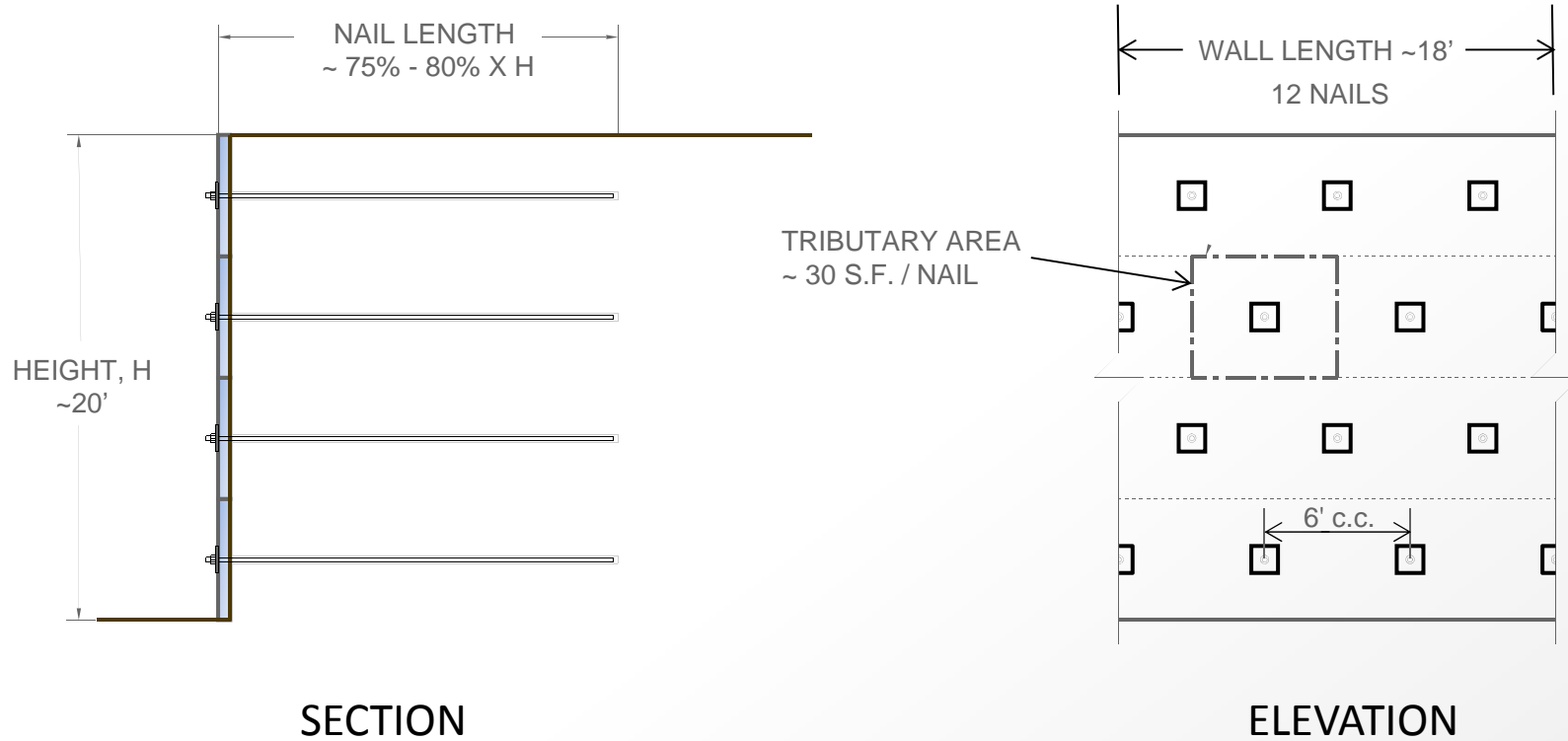
SOIL NAIL WALL CONSTRUCTION



SOIL NAIL WALL CONSTRUCTION



FOR WALL HEIGHT ~ 20



NAIL LENGTH $\sim 15'$ ea.
12 NAILS $\times 15' = 180'$ OF DRILLING

OR A NAIL DENSITY OF
 $\sim 10'$ OF DRILLING PER L.F. OF WALL





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Larry



Mike



Paul



Chris

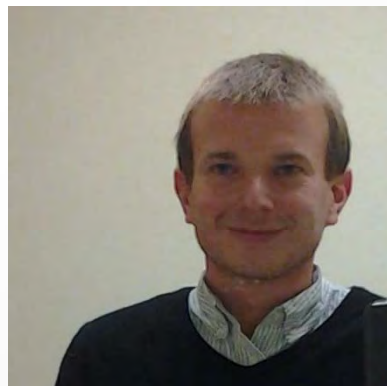


Tom



End 1

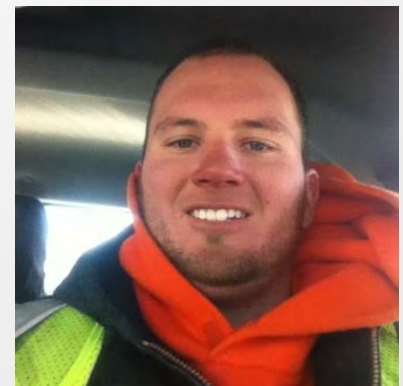
Rich



David



Dan



Connor



African Meetinghouse

8 Smith Court • Boston









Built in 1806

(Cost \$7,500)



**Oldest Black Church
Still Standing in the United States**



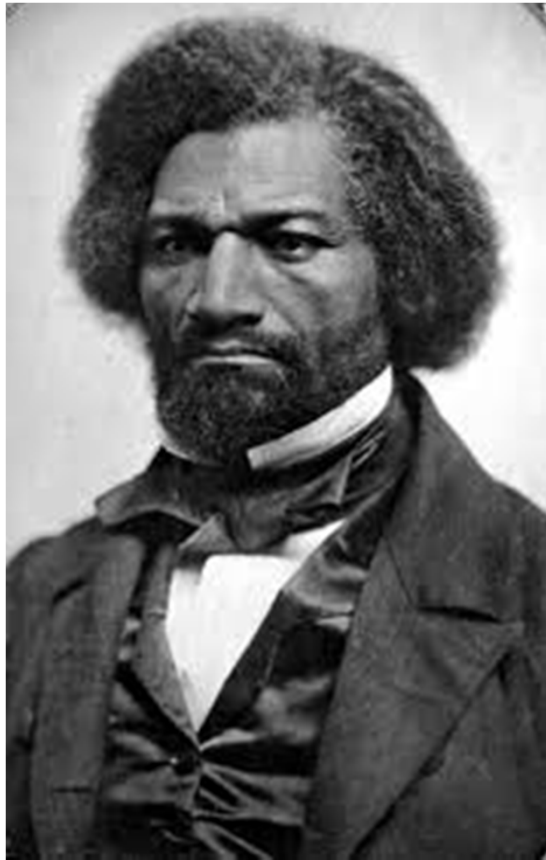


2006 Restored to
1855 Appearance
(Completed 2012)



Cost \$9.5 Million





Frederick Douglass

- Escaped Slave
- Leader in Abolitionist Movement
- Dazzling Orator – 1860 Speech

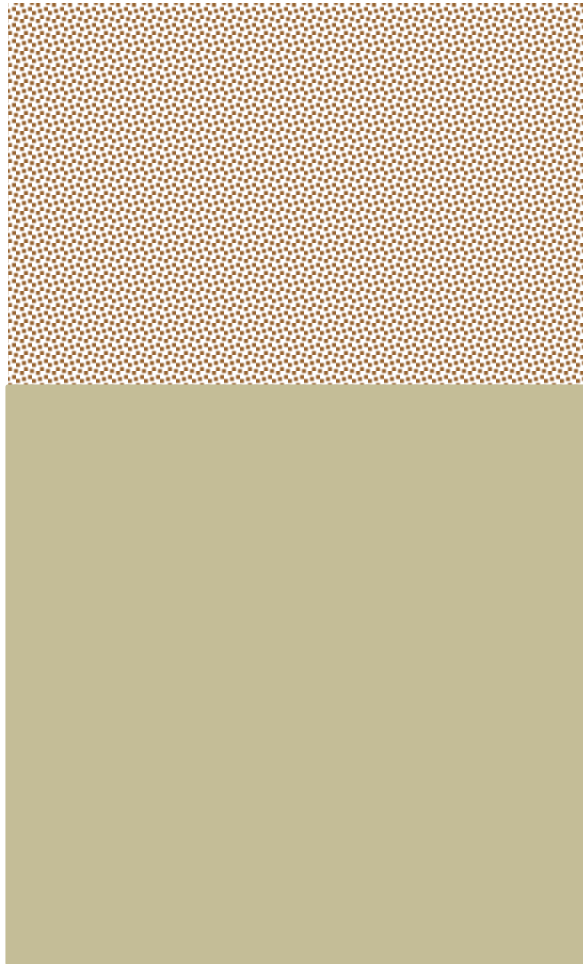


MICROPILES *TYPE 1 (>99%)*

- Deep Foundation Elements
- *Structural* Elements
- Installed by Drilling (usually)
- Small Diameter (\leq 12-inch Diameter)
- Directly Loaded
- Load Applied Near Ground Surface
- Penetrate Weak Strata
- Transfer Load to (deep) Bearing Strata



MICROPILE INSTALLATION



WEAK STRATA

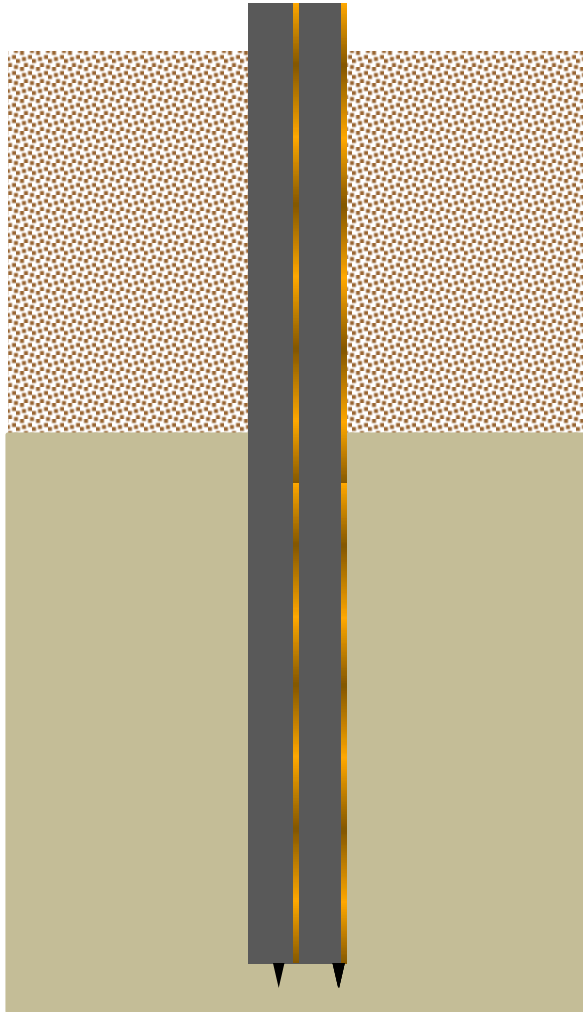
- Urban Fill
 - Organic Soil
 - Peat
 - Very loose Sand
 - Soft Silt or Clay
-

BEARING STRATA

- Sand
- Sand & Gravel
- Glacial Till
- Stiff/Hard Clay
- Bedrock



MICROPILE INSTALLATION



WEAK STRATA

- Urban Fill
- Organic Soil
- Peat
- Very loose Sand
- Soft Silt or Clay

BEARING STRATA

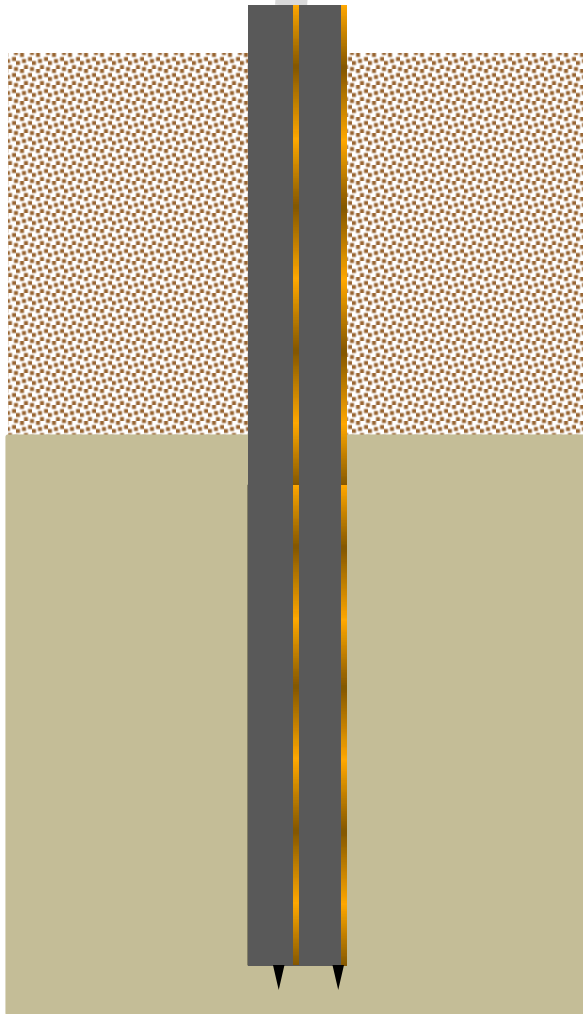
- Sand
- Sand & Gravel
- Glacial Till
- Stiff/Hard Clay
- Bedrock



MICROPILE INSTALLATION

PLACE
CORE

ADD GROUT



WEAK STRATA

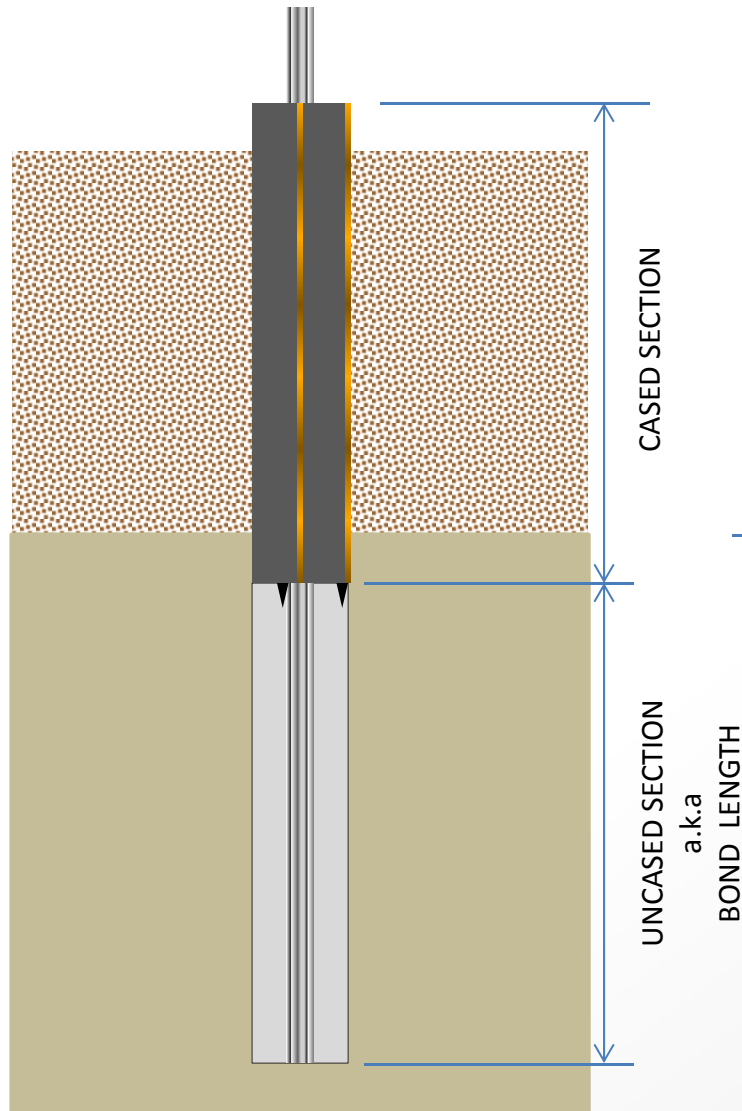
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BEARING STRATA

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MICROPILE INSTALLATION



WEAK STRATA

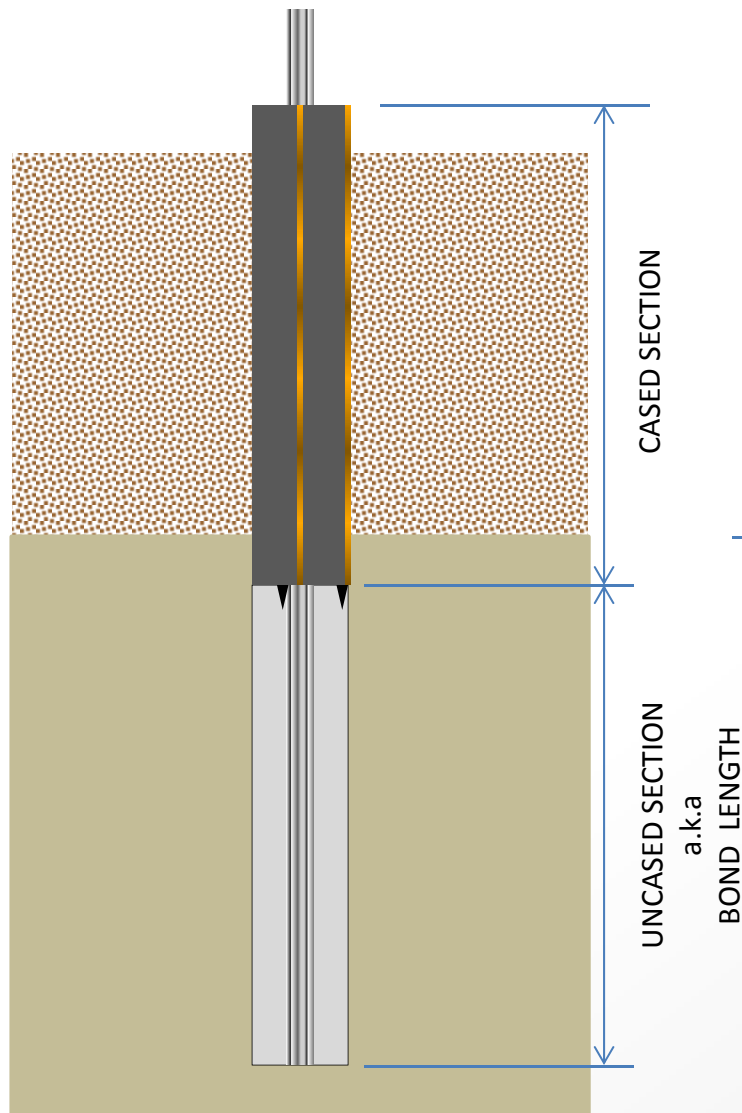
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MICROPILE INSTALLATION



WEAK STRATA

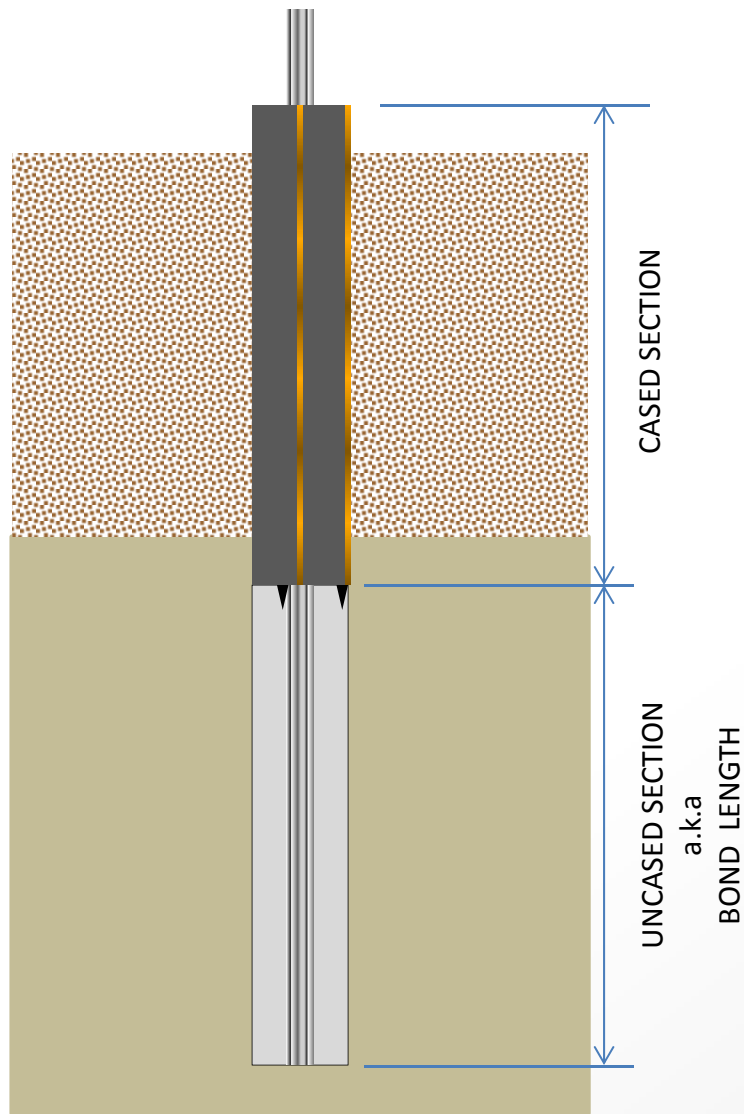
- Urban Fill
- Organic Soil
- Peat
- Very loose Sand
- Soft Silt or Clay

BEARING STRATA

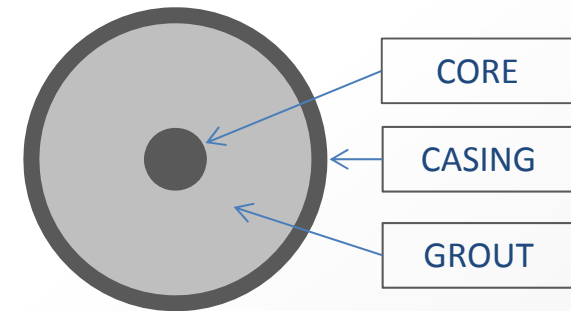
- Sand
- Sand & Gravel
- Glacial Till
- Stiff/Hard Clay
- Bedrock



MICROPILE DESIGN

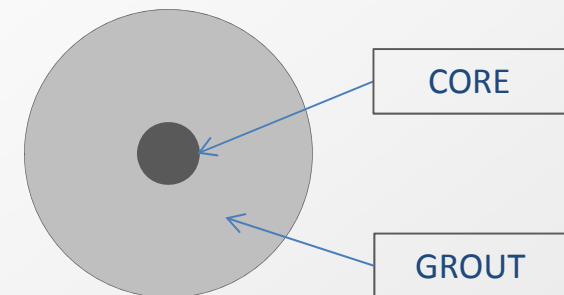


CASED SECTION



$$A_{cased} \rightarrow \text{Casing} + \text{Core} + \text{Grout}$$

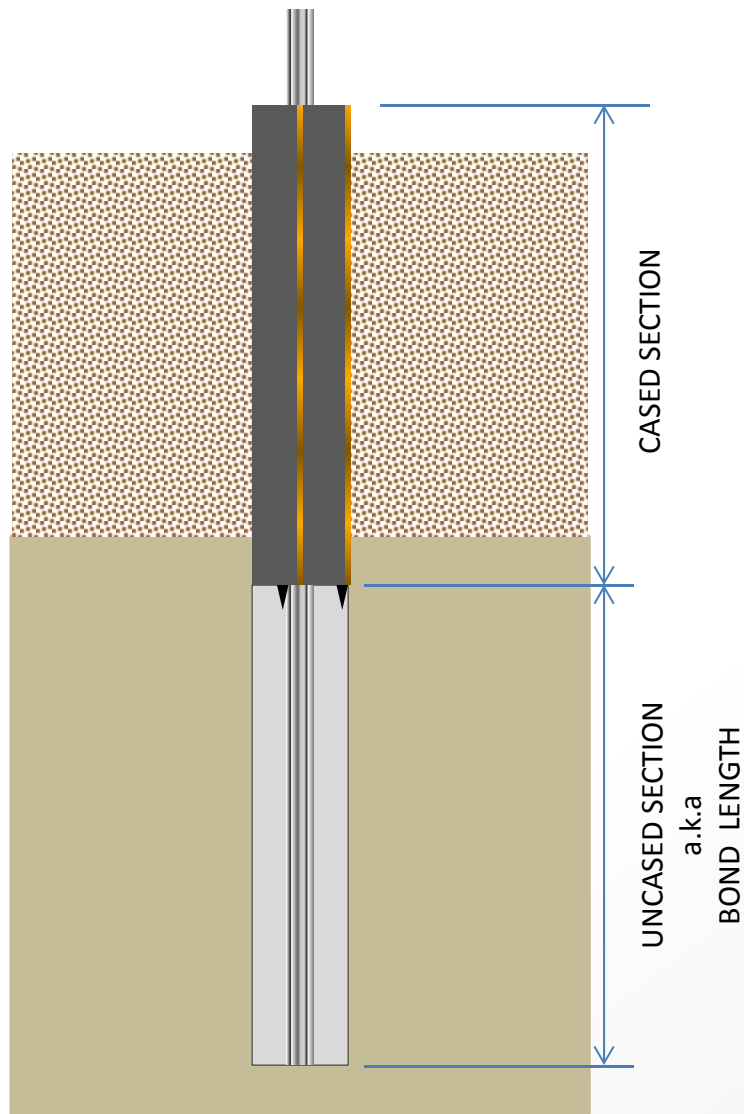
UNCASED SECTION



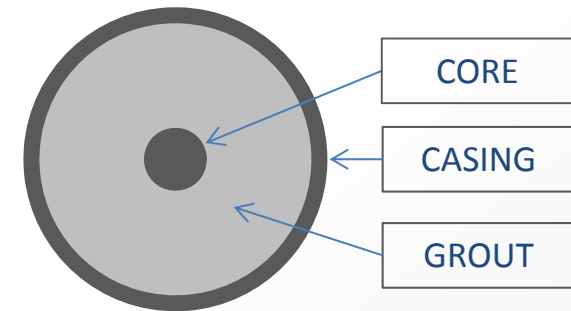
$$A_{bond} \rightarrow \text{Core} + \text{Grout}$$



MICROPILE DESIGN

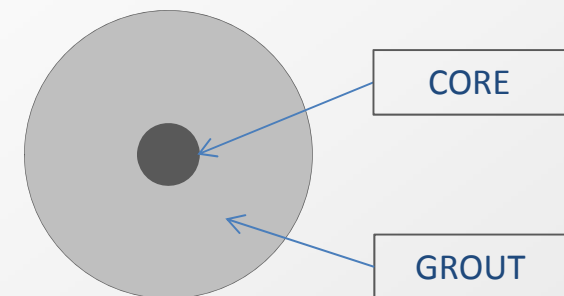


CASED SECTION



$$A_{cased} \rightarrow \text{Casing} + \text{Core} + \text{Grout}$$

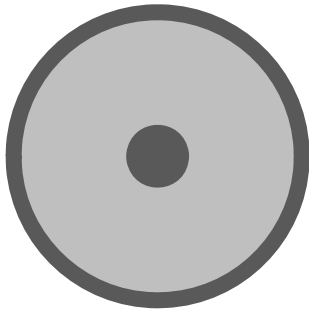
UNCASED SECTION



$$A_{bond} \rightarrow \text{Core} + \text{Grout}$$



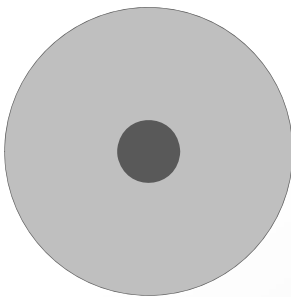
CASED SECTION



$$\frac{P}{A_{cased}} \leq F_{c \text{ allowable}}$$

where: $A_{cased} \rightarrow$ Casing + Core + Grout

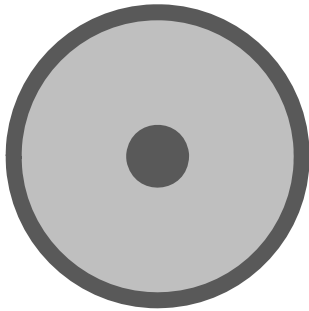
(Bond Length) UNCASED SECTION



$$\frac{P}{A_{bond}} \leq F_{b \text{ allowable}}$$

where: $A_{bond} \rightarrow$ Core + Grout

CASED SECTION

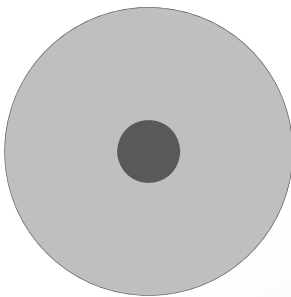


$$P_{all} \leq A_{cased} \times F_{c \text{ allowable}}$$

$A_{cased} \rightarrow$ Casing + Core + Grout

UNCASED SECTION

(Bond Length)



$$P_{all} \leq A_{bond} \times F_{b \text{ allowable}}$$

$A_{bond} \rightarrow$ Core + Grout

CODE BASED DESIGN – Most are ASD



CASED SECTION

$$P \leq 0.33(f'_{c \text{ grout}} \times A_{\text{grout}}) + 0.4(F_y \text{ casing} \times A_{\text{casing}} + F_y \text{ core} \times A_{\text{core}})$$

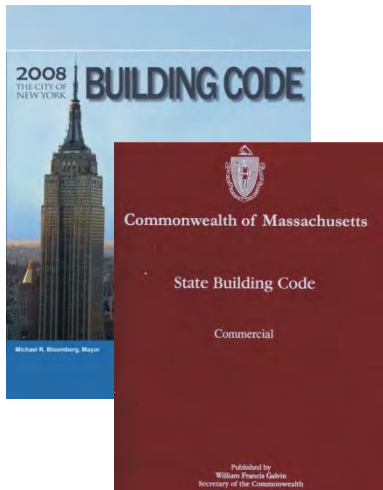
UNCASED (a.k.a BOND LENGTH or EMBEDMENT LENGTH)

$$P \leq 0.33(f'_{c \text{ grout}} \times A_{\text{grout}}) \times 0.4(F_y \text{ core} \times A_{\text{core}})$$

$F_{y \text{ steel}}$ is the smaller of : $0.4F_y \text{ casing}$

$0.4F_y \text{ core}$

$30,000 \text{ psi}$

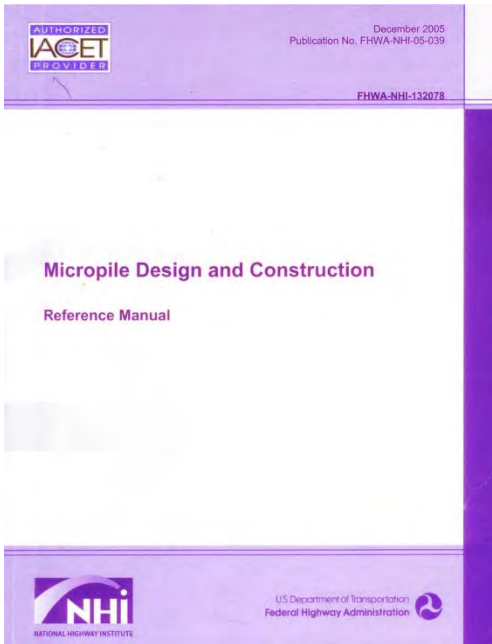


Massachusetts State and New York City Codes

$$0.33f'_{c \text{ grout}} \leq 1,600 \text{ psi}$$



FHWA — *Micropile Design and Construction Reference Manual* (Also ASD)



CASED SECTION

$$P \leq 0.4(f_{c \text{ grout}} \times A_{\text{grout}}) \times 0.47F_{y \text{ steel}}(A_{\text{casing}} + A_{\text{core}})$$

$F_{y \text{ steel}}$ is the smaller of : $F_{y \text{ casing}}$

$F_{y \text{ core}}$

87,000 psi

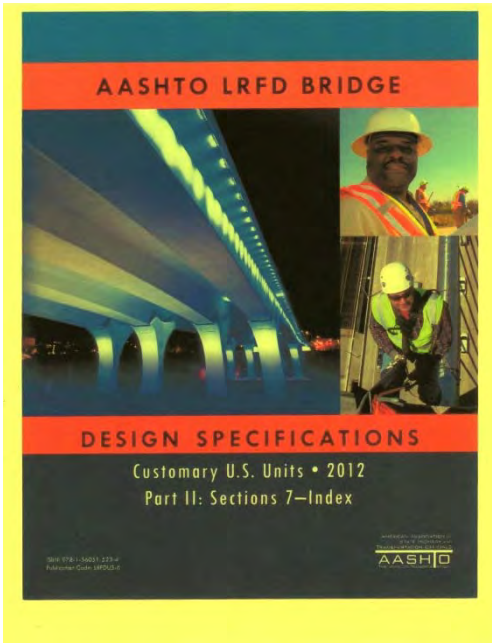
(Strain Compatibility)

UNCASED LENGTH

$$P \leq 0.4(f_{c \text{ grout}} \times A_{\text{grout}}) \times 0.47(F_{y \text{ steel}} \times A_{\text{core}})$$



AASHTO – Design Specifications (LRFD)



CASED SECTION

$$\phi P \leq 0.85\phi[(0.85f'_{c \text{ grout}} \times A_{\text{grout}}) + F_{y \text{ steel}}(A_{\text{casing}} + A_{\text{core}})]$$

$F_{y \text{ steel}}$ is the smaller of : $F_{y \text{ casing}}$

$F_{y \text{ core}}$

87,000 psi

$\Phi = 0.7$ for compression

UNCASED LENGTH

$$\phi P \leq 0.85\phi[(0.85f'_{c \text{ grout}} \times A_{\text{grout}}) + (F_{y \text{ steel}} \times A_{\text{core}})]$$





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Reticulate / Reticulated ?

Adjective - *Re·tic·u·late* [*Ri-tik-yuh-lit*]

1. Netted; Covered With a Network.
 2. Netlike.
-

Verb - *Re·tic·u·lat·ed* [*Ri-tik-yuh-leyt*]

(Used with an object)

3. To Form Into a Network.



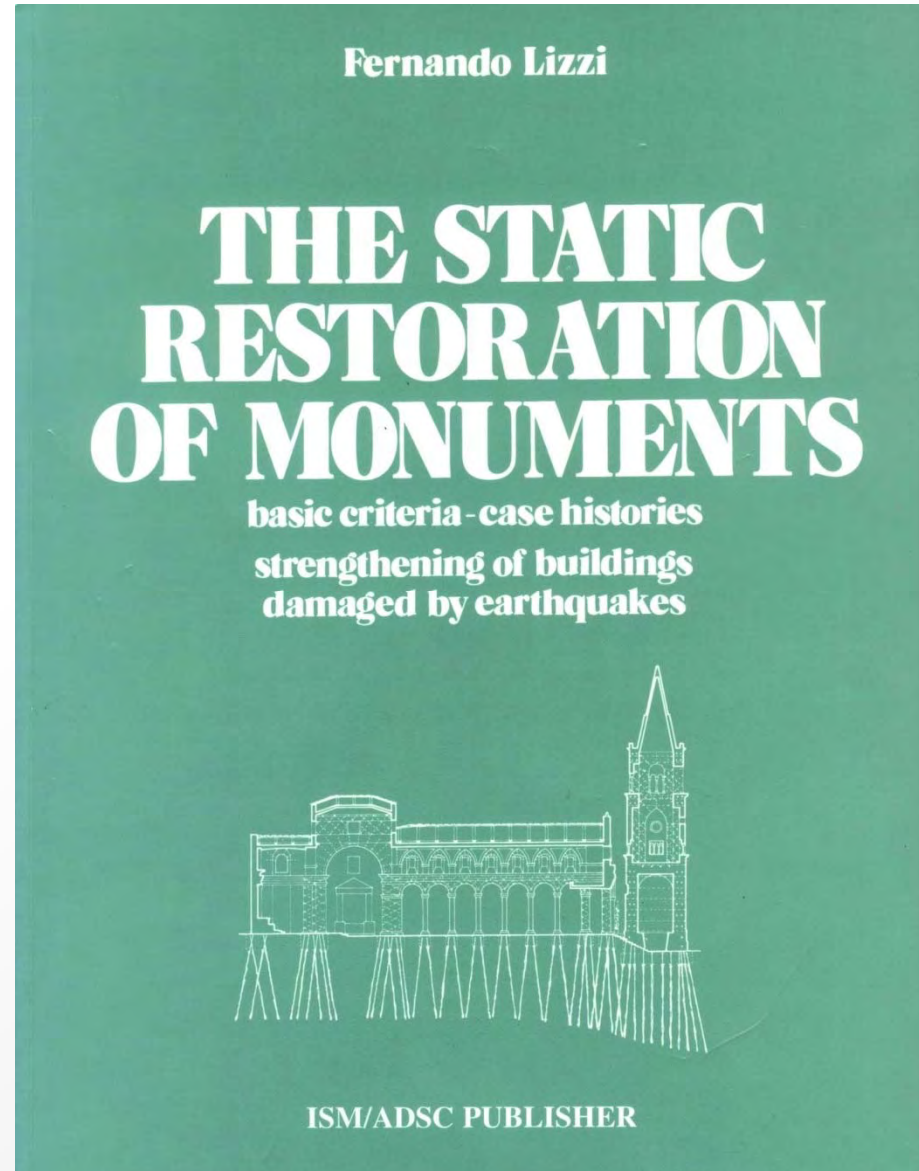
Pali Radicé [*Italian trans.* “Root Piles”]

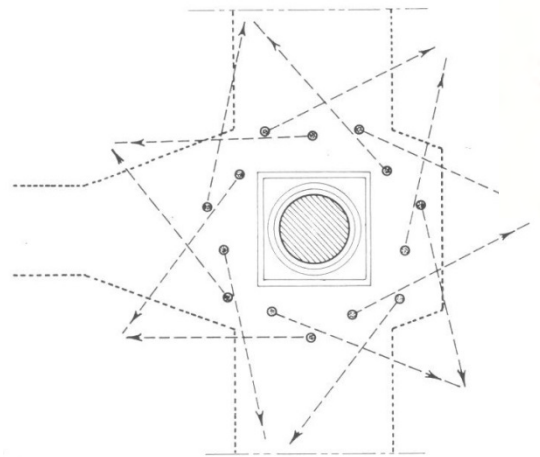
Reticulated Root Piles : a network of micropiles



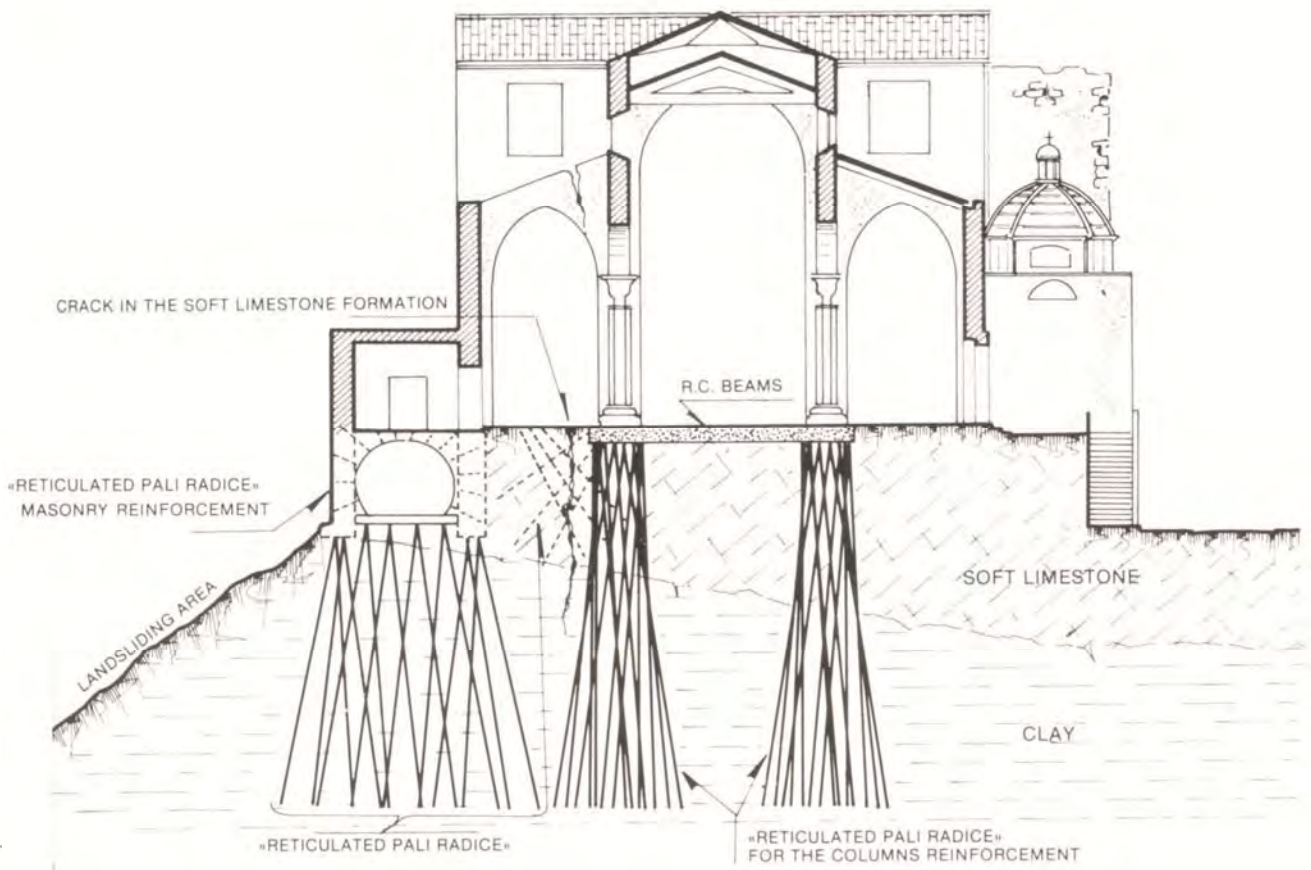
NETWORKED MICROPILES: *TYPE 2 (<1%)*

(Reticulated Root Piles)





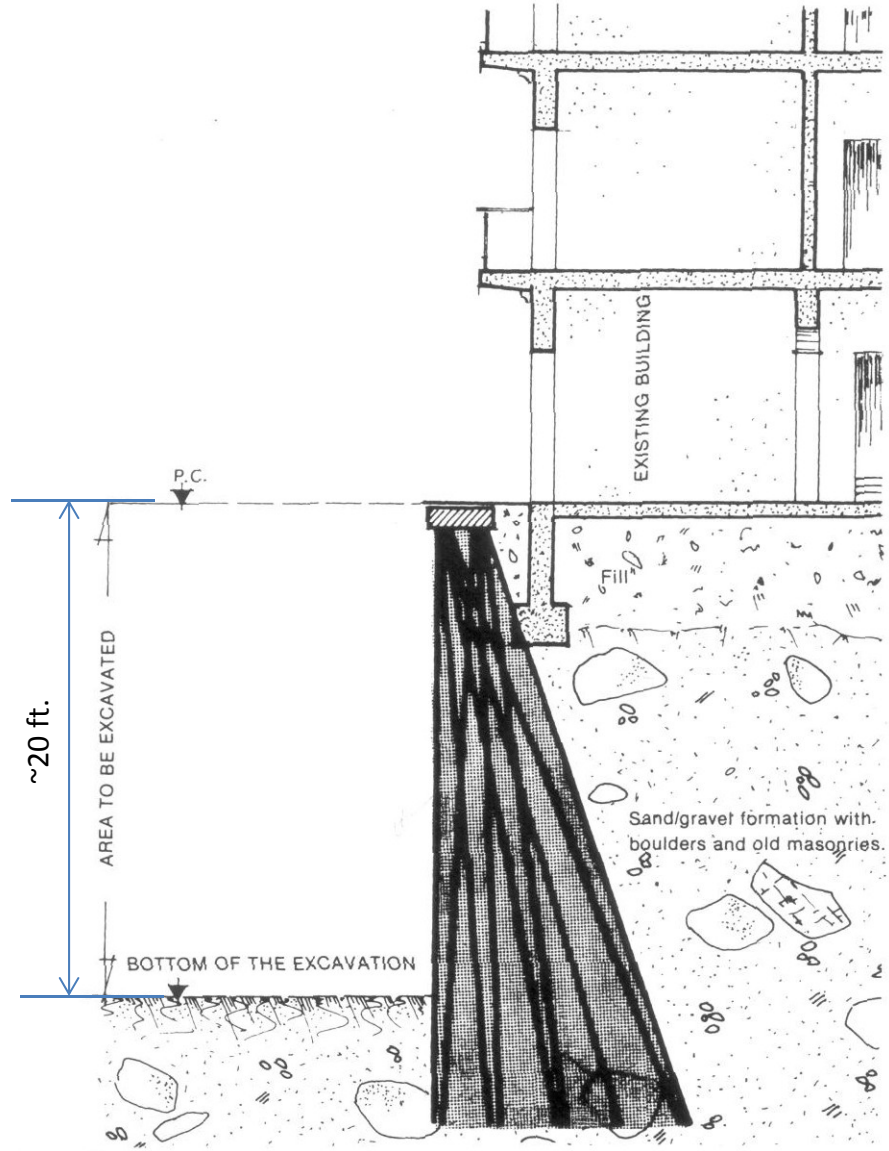
Column Cross Section



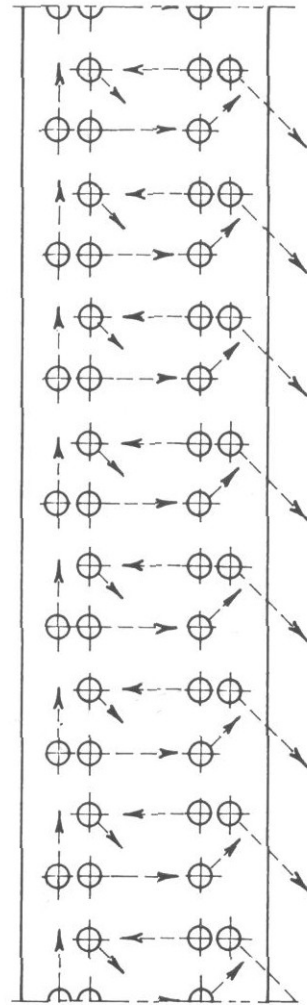
Elevation View



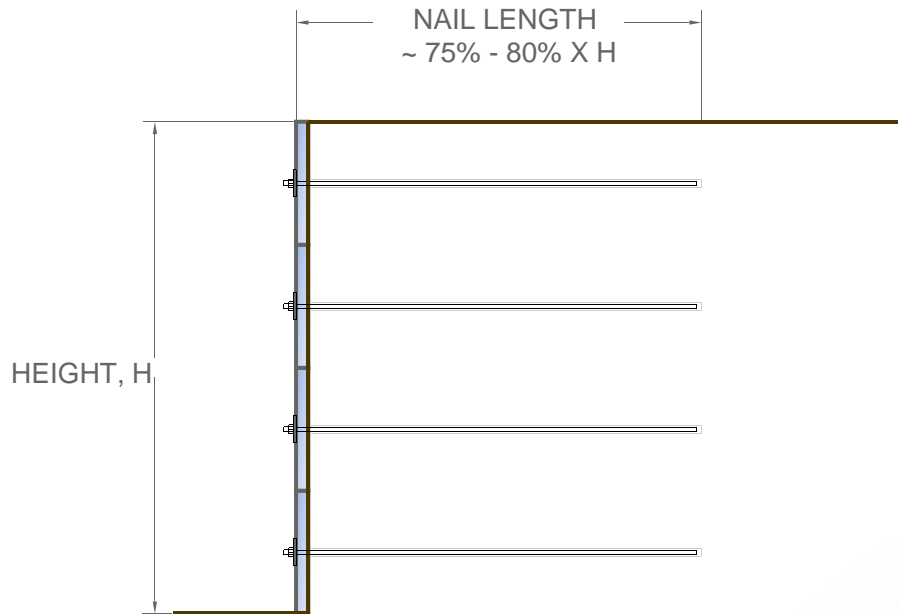
VERTICAL CROSS-SECTION



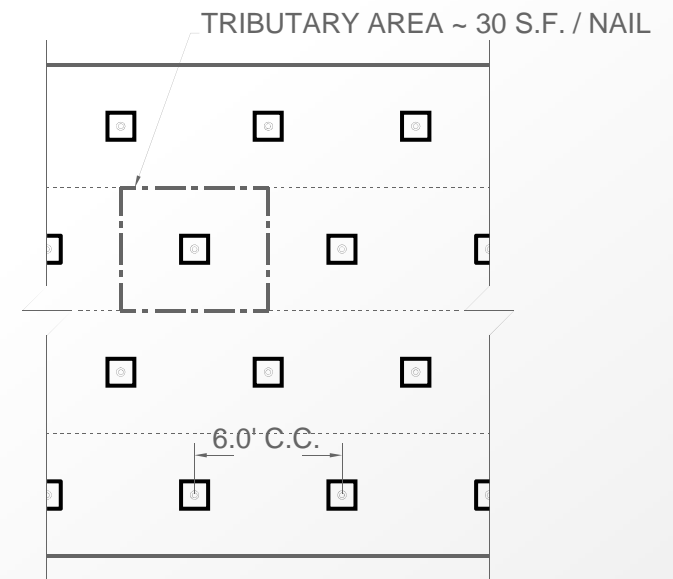
PLAN AT GROUND LEVEL



FOR HEIGHT ~ 20



SECTION



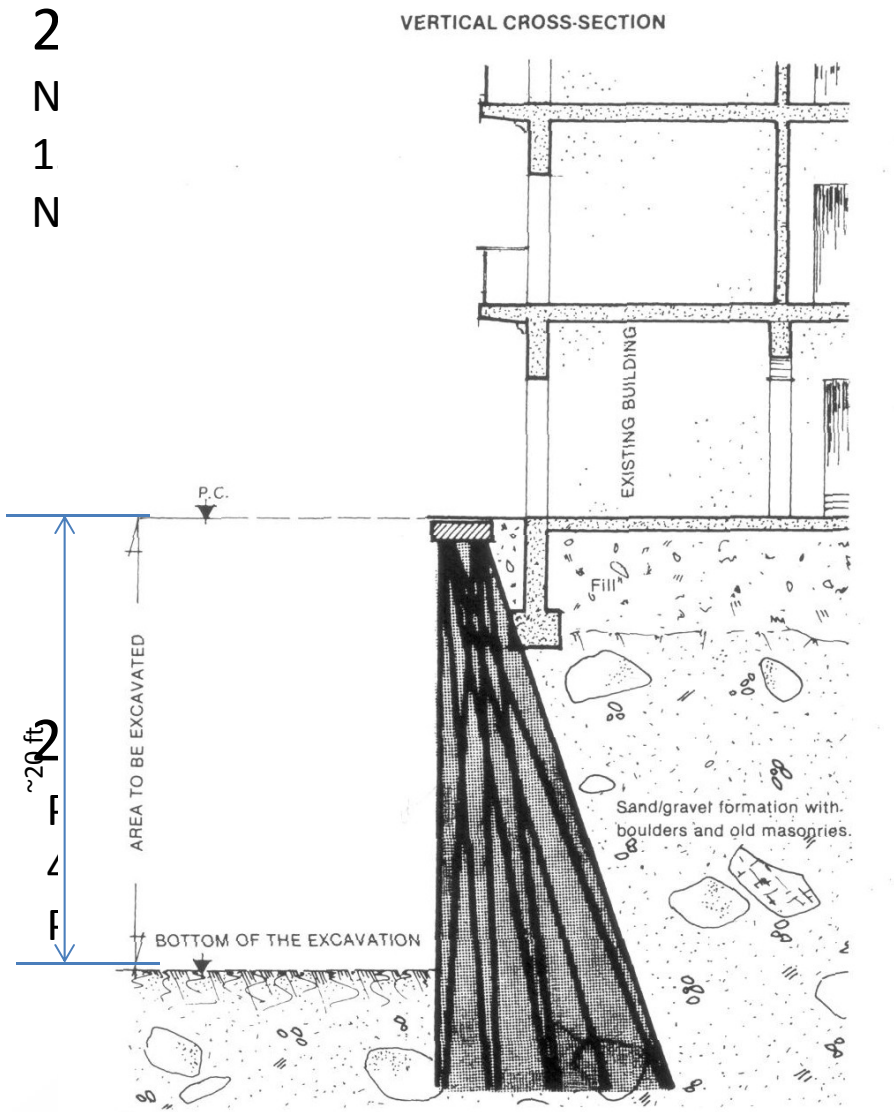
ELEVATION

NAIL LENGTH ~ 15' ea.
12 NAILS x 15' = 180' OF DRILLING

OR A NAIL DENSITY OF
~ 10' OF DRILLING PER LF. OF WALL

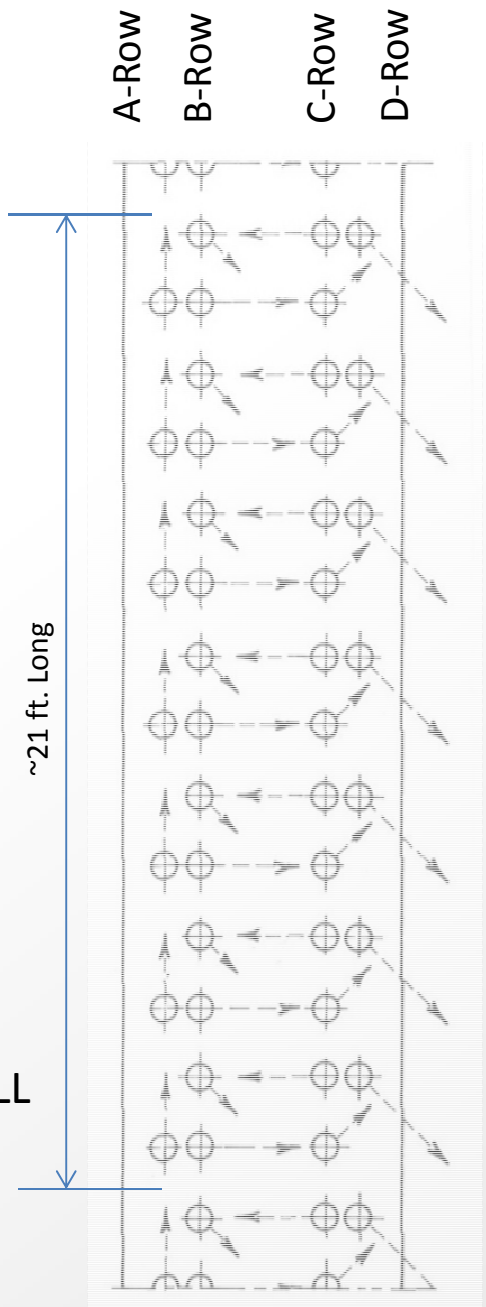


2
N
1
N



LL

WALL





2006 Restored to
1855 Appearance
(Completed 2012)



Cost \$9.5 Million

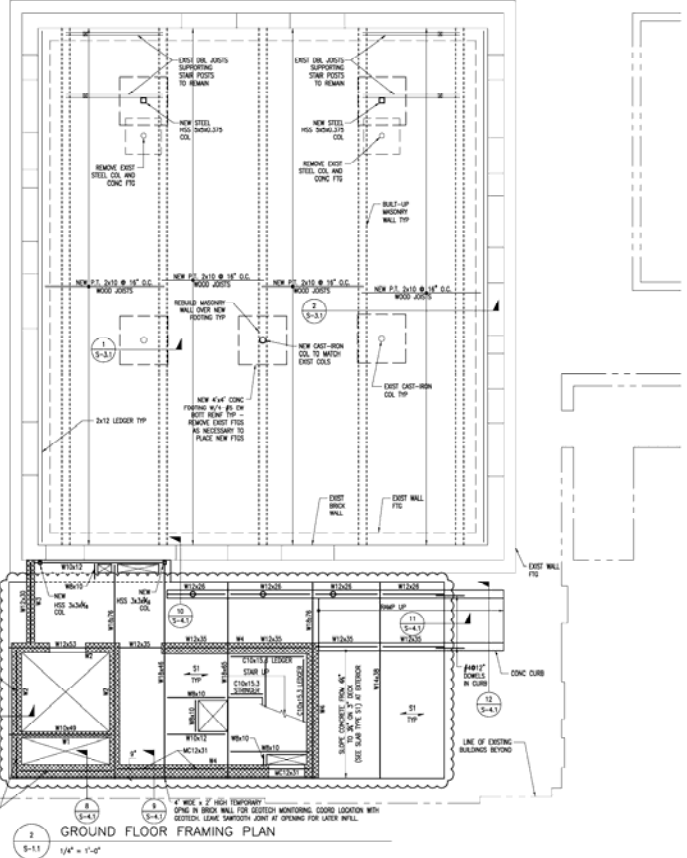
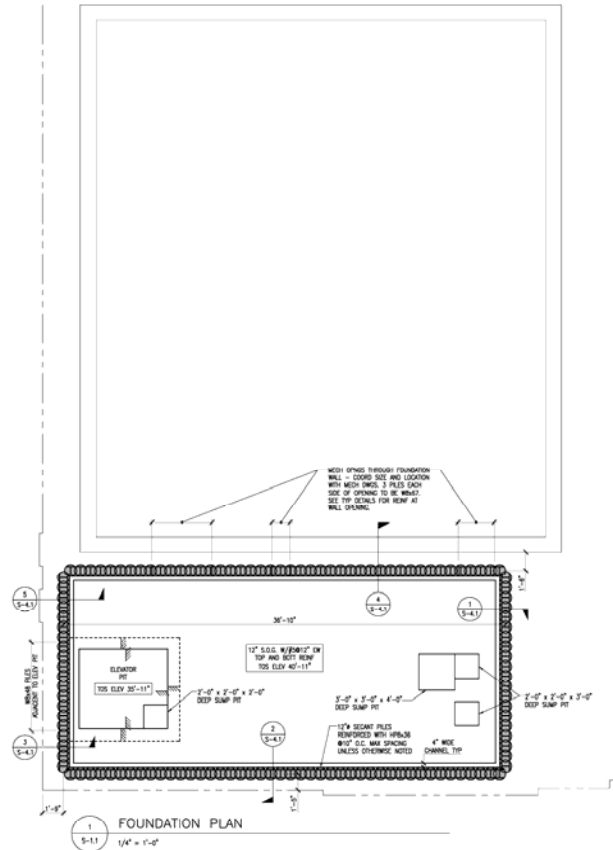








MASONRY WALL SCHEDULE			
MARK	WALL TYPE	VERTICAL REINF	HORIZONTAL REINF
W1	8" CMU	#3@8"	3/16" WOOD TYPE EACH COURSE
W2	4" BRICK TYPING	#3@8" IN CMU	3/16" WOOD TYPE EACH COURSE IN CMU
W3	3 WYPC BRICK 4" THICK	#3@12" IN WALL Cavity	N/A
W4	3 WYPC BRICK 12" THICK	#3@12" IN WALL Cavity	N/A



GENERAL NOTES:

1. ——— SIZES 36" LB CONCRETE ON 3", 18 GA COMPOSITE STEEL DECK (84" TOTAL BOTH) REINFORCED WITH W/F #4-#2 @ 8" O.C.
2. PROVIDE ONE SHEAR STUD PER FOOT AT ALL BEAMS SUPPORTING CONCRETE SLAB. STUDS SHALL BE 1/2" x 1/4" LONG.
3. SECANT PILE WALL LAYOUT SHOWN IS REQUIREMENT FOR PERMANENT CONDITION. TEMPORARY EXCAVATION SUPPORT CONDITION TO BE DESIGNER IN CONSULTATION FOR EXCAVATION OPENING AND PROTECTING.
4. SEE ARCH DRAWINGS FOR DIMENSIONS NOT SHOWN.

KEY PLAN

Architects
 280 Brattle Street
 Cambridge, MA 02138
 Tel 617-488-7500 Fax 617-488-7505

RSE
 Registered So Engineers
 225 Mount Auburn Street
 Cambridge, MA 02138
 Tel 617-488-7500 Fax 617-488-7505

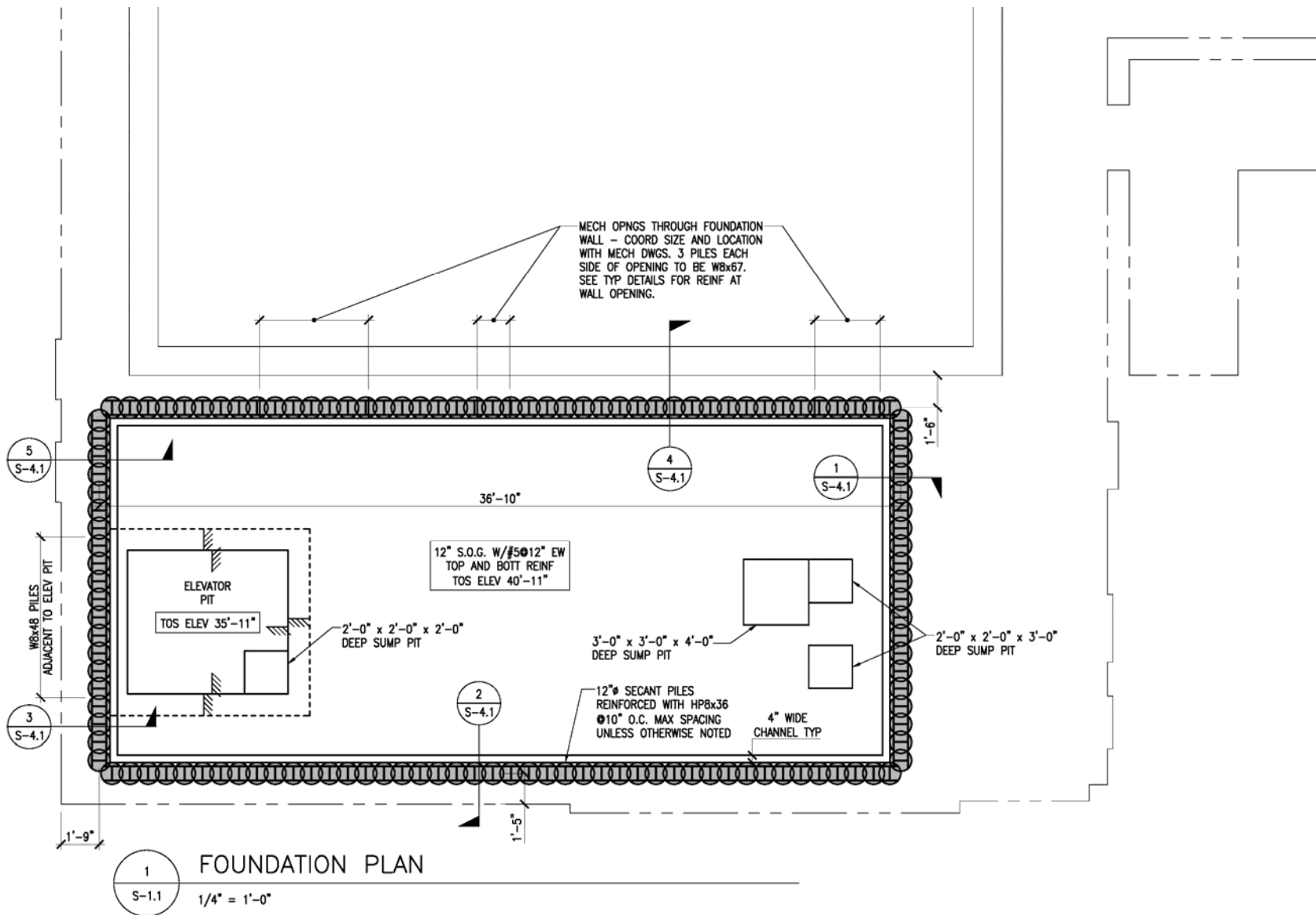
**RESTORATION OF THE AFRICAN MEETING HOUSE
 THE MUSEUM OF AFRO-AMERICAN HISTORY**
 SOUTH COAST, BOSTON, MA

STRUCTURAL FRAMING PLANS

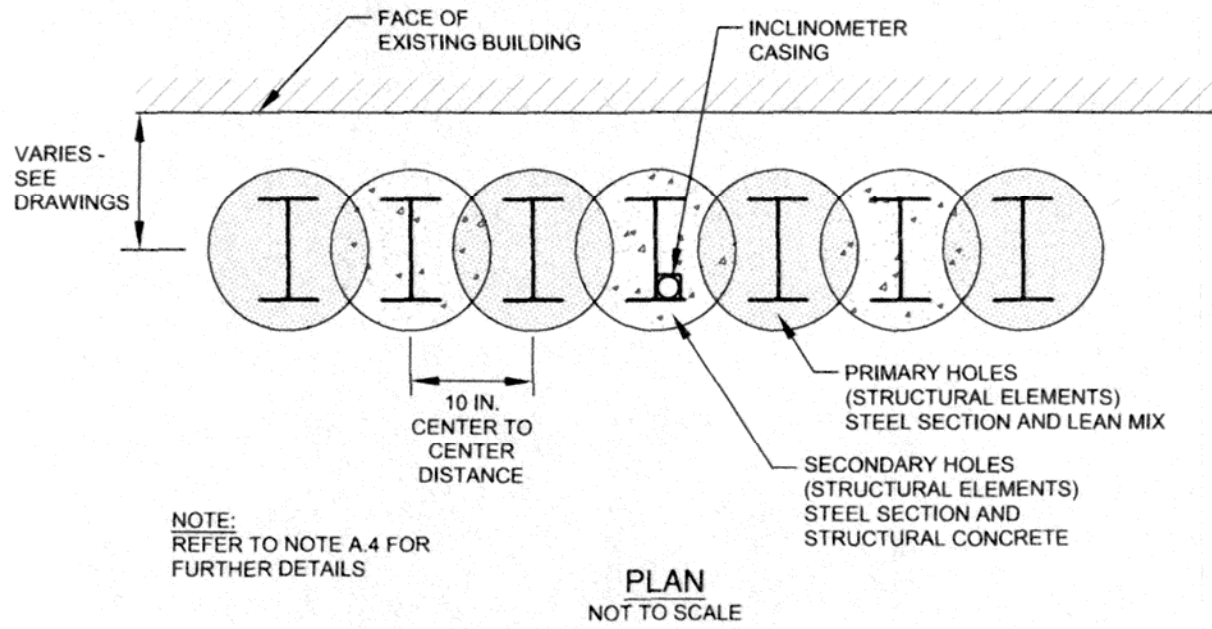
DRAWING NO. S-1.1

DATE: MARCH 21, 2008
 DRAWN BY: MJS
 RSE PROJECT NO. AMH





SECANT PILES





End 5





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End 6





African Meetinghouse

8 Smith Court • Boston











































01/28/2011 08:27 AM













01/28/2011 08:03 AM

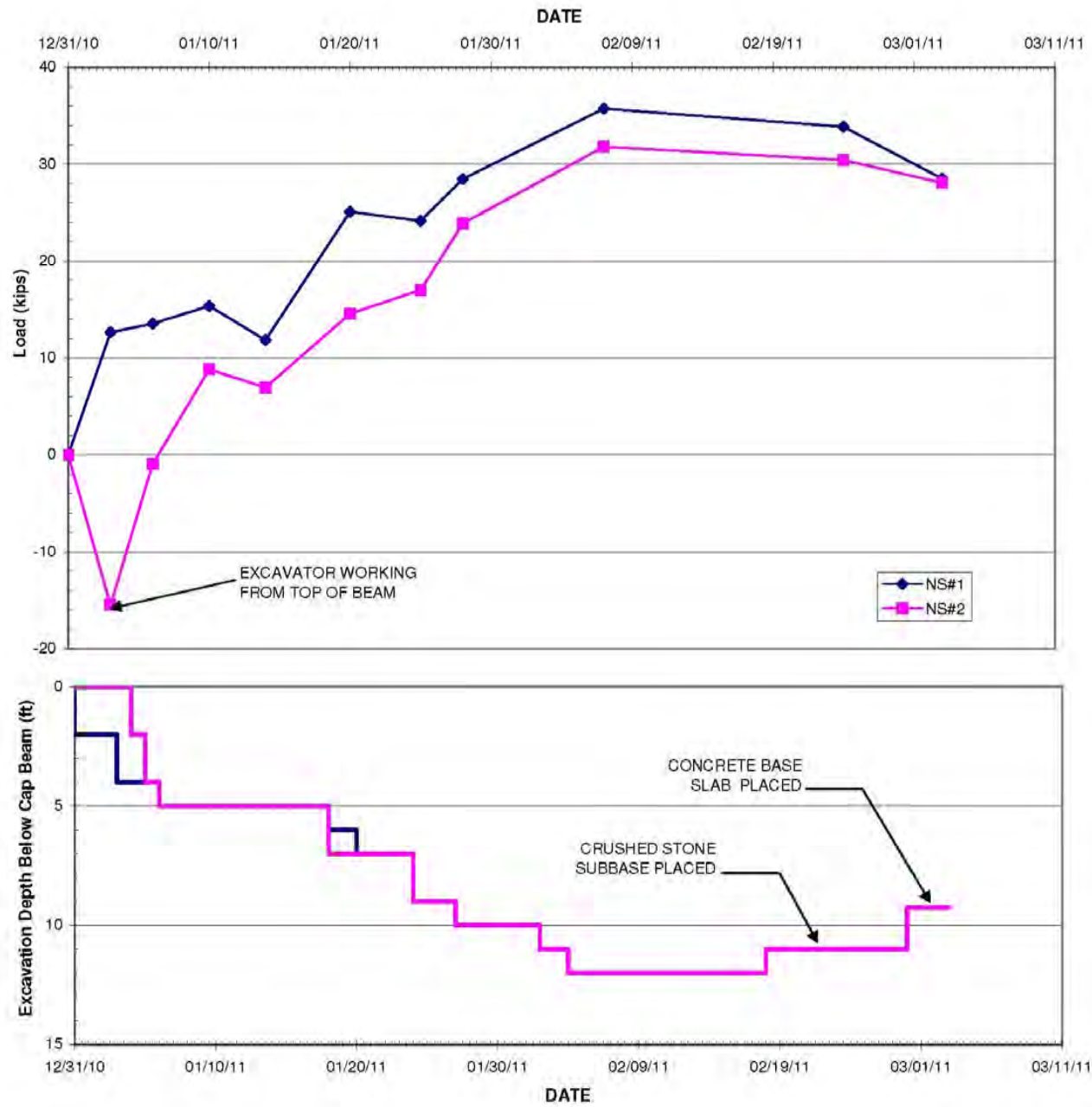








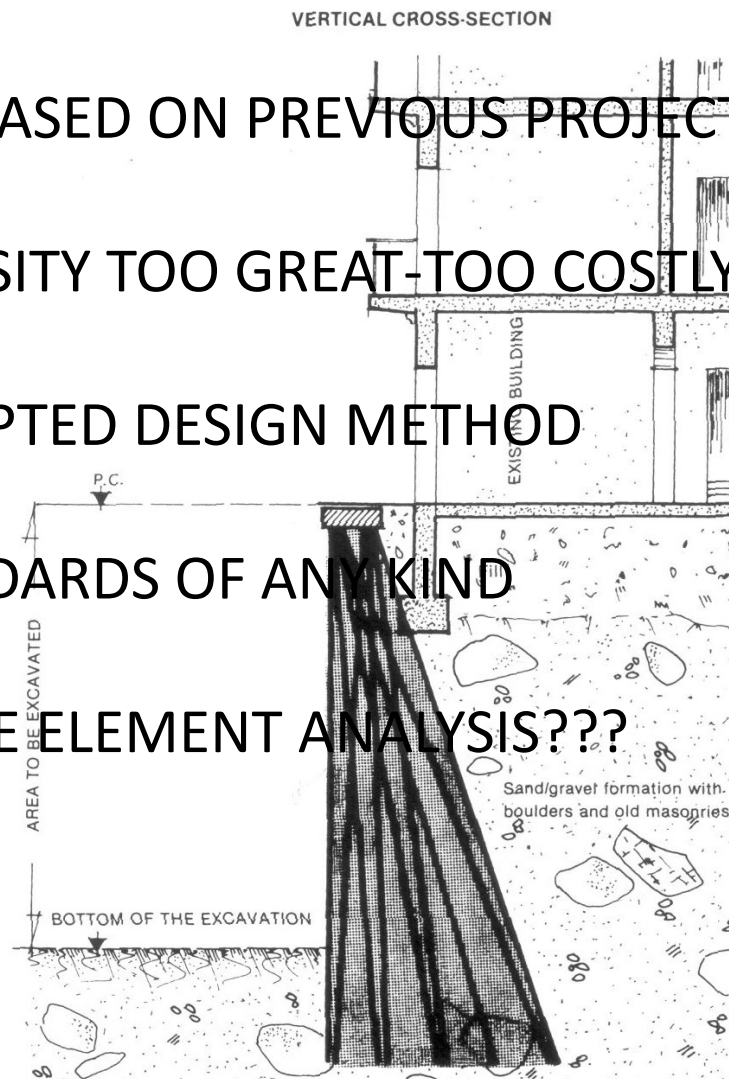




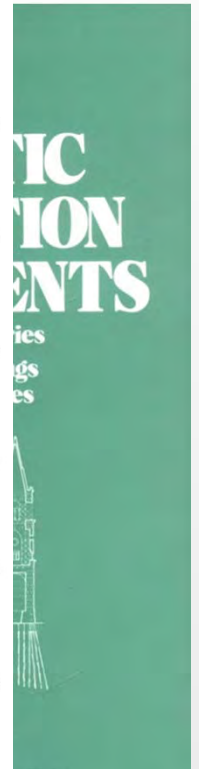
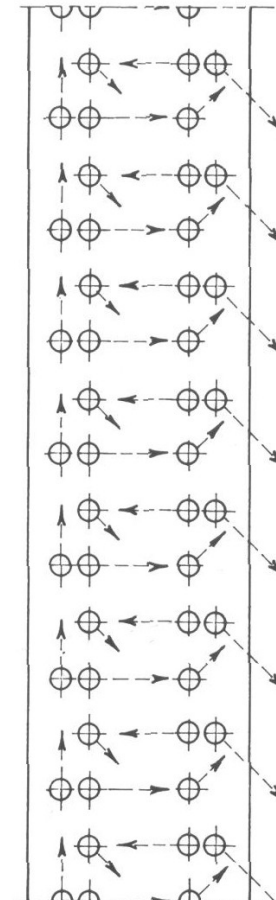
FUTURE OF TYPE 2 NETWORKED MICROPILES???

(Reticulated Root Piles)

- DESIGN BASED ON PREVIOUS PROJECTS
- PILE DENSITY TOO GREAT-TOO COSTLY
- NO ACCEPTED DESIGN METHOD
- NO STANDARDS OF ANY KIND
- 3-D FINITE ELEMENT ANALYSIS???



PLAN AT GROUND LEVEL





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